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Coastal Engineering Technical Note

BIOLOGICAL EFFECTS OF BREAKWATER CONSTRUCTION ON AQUATIC COMMUNITIES IN THE GREAT LAKES

PROBLEM: Breakwaters and jetties are common engineering solutions for rectifying navigation problems in coastal systems. Construction of breakwaters and jetties may produce short- or long-term impacts on aquatic communities as a consequence of altered hydrodynamic conditions, sedimentation patterns, water quality parameters, and other physical or chemical factors. These alterations, in combination with habitat changes manifested by the presence of the structure(s), may affect the character of aquatic communities in the project area. Very little information is available which describes the biological effects of such structures, particularly in the Great Lakes region. Therefore, an environmental monitoring program to assess the impacts of navigation project construction at a Great Lakes site was initiated.

BACKGROUND: Construction of two rubble-mound breakwaters at a natural inlet into West Harbor, Ohio (in the western basin of Lake Erie), occurred between August 1981 and November 1982 (Figure 1). Objectives of the construction project were to alleviate shoaling of the natural channel and to provide safe access for shallow-draft recreational vessels from Lake Erie into West Harbor. An investigation to evaluate the biological effects of breakwater construction and associated channel dredging involved pre-, during-, and post-construction sampling of aquatic floral and faunal communities, as well as water quality monitoring, at the project site (Manny et al. 1984). Bottom type at the construction site was found to be predominantely fine to coarse sand. Sampling was conducted along control transects both up- and downdrift of the breakwaters and along effect transects in the immediate vicinity of the structures. A characterization of the aquatic community which developed on the substratum on and around the structures was also performed, including an assessment of fish populations utilizing the structures as spawning habitat.

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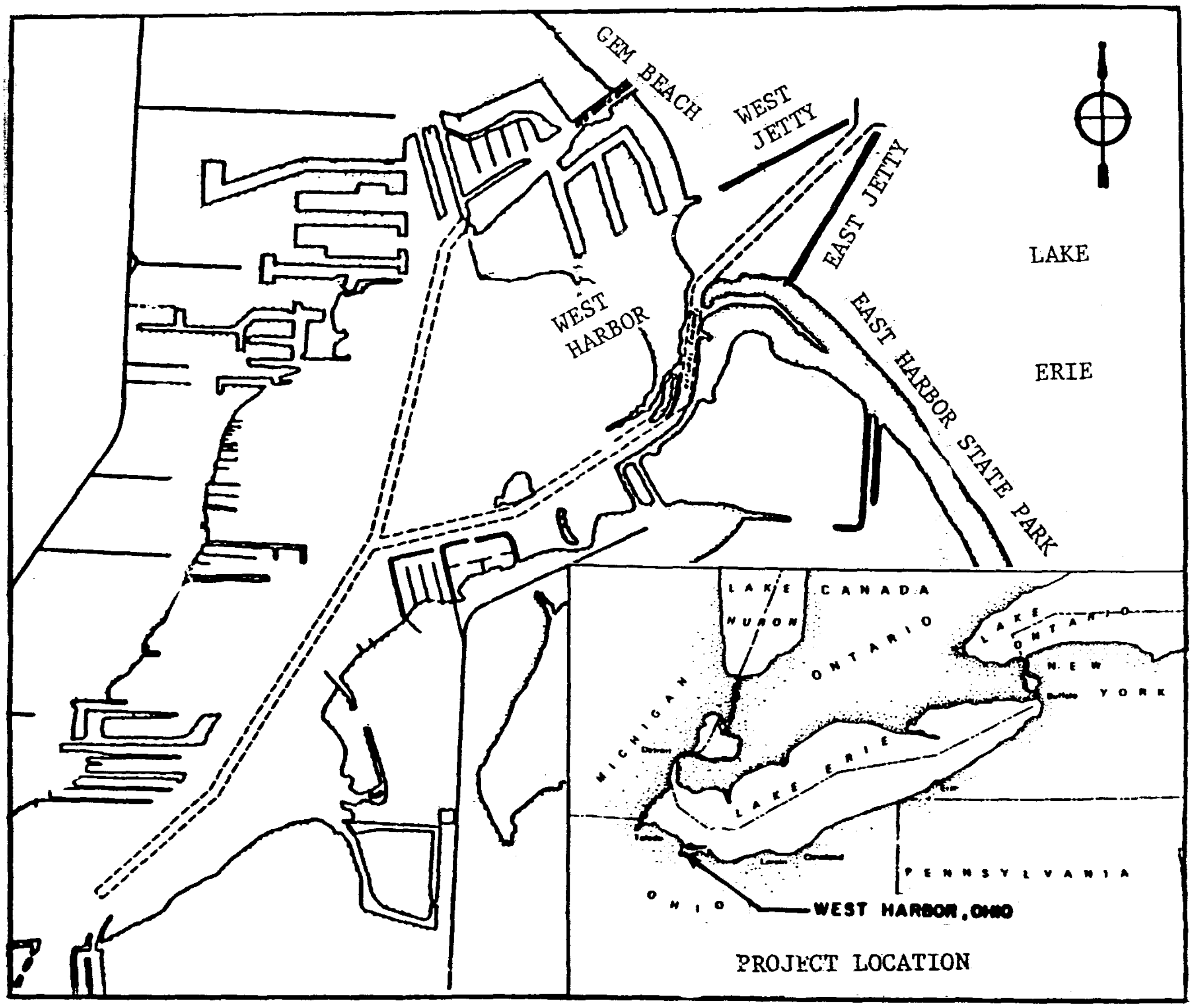

Figure 1. Location of the West Harbor, Ohio, project site in the western basin of Lake Erie

WATER QUALITY EFFECTS: Changes noted in surface and bottom water temperatures between sampling periods were within the normal range of seasonal variations. Dissolved oxygen concentrations in bottom waters, however, were substantially depressed on the effect transects and one control transect at the time (August 1983) when post-construction samples were taken. These lowered dissolved oxygen levels did not appear to be a direct result of construction activities but rather were a more widespread phenomenon, possibly due to an incursion of

oxygen-deprived offshore waters. A general pattern of decreasing turbidity and suspended solids concentration with increasing water depth was observed on all transects throughout the study. Turbidity and suspended solids levels of surface waters on the effect transects were found to be somewhat elevated in samples taken in the during-construction phase. This was apparently a short-term impact which was no longer evident after construction operations were concluded. Wind-generated turbulence also appeared to be partially responsible for the elevated values measured.

BIOLOGICAL EFFECTS: Dominant components of the macrozoobenthos along all transects were oligochaetes (worms) and chironomids (midges). High densities of the polychaetous worm (*Manayunkia speciosa*) were also present. A trend of increasing benthos biomass and abundance with increasing water depth was noted during all sampling periods. Significantly higher abundances of benthos were found along the effect transects than along the control transects. These patterns were consistent throughout the study, indicating that adverse construction impacts on macrozoobenthos were minimal or absent. In fact, post-construction benthos samples within the dredged channel between the breakwaters revealed much higher abundances than were present prior to construction.

In addition to oligochaetes and chironomids, amphipods (*Gammarus* spp.) were dominant members of the fauna colonizing the breakwaters. Community development was rapid, with a greater taxonomic variety of benthos becoming established on the structures than was present in sediments along the transects. Severe winter conditions such as ice formation and abrasion caused tremendous seasonal fluctuations in the breakwater biota. This is in contrast with colonization patterns seen on rubble-mound structures in temperate marine environments (see CETN-V-13 and CETN-V-18).

Initial floral colonizers of the structures included the diatom *Gomphonema olivaceum* and the green algae *Ulothrix* spp., but the green alga *Cladophora glomerata* became dominant with time. Algal colonizers provided surface area for attachment of epiphytic organisms, which in turn form the basis of food webs through invertebrate grazers to fishes. Chlorophyll and biomass values for breakwater periphyton peaked during the first year of each structure's existence, followed by reduced values the ensuing year. This colonization pattern was typical of that reported for other newly exposed

substrata in the Great Lakes. Complete stabilization of periphyton abundance and species composition on the breakwaters had not been achieved by the time the study was concluded.

Fish samples taken on control transects and adjacent to the structures yielded over 33,000 specimens representing 30 species. On control transects white bass (Morone chrysops), gizzard shad (Dorosoma cepedianum), and freshwater drum (Aplodinotus grunniens) composed 74 percent of the catch, whereas adjacent to the breakwaters spottail shiner (Notropis hudsonius), freshwater drum, and yellow perch (Perca flavescens) dominated the catch. White perch, (Morone americana) and alewives (Alosa pseudoharengus) were also present in considerable numbers. Catches on transects declined in successive pre-, during-, and post-contruction samples. This trend, however, was not linked to construction effects because similar decreases in fish stocks occurred concurrently throughout the western basin of Lake Erie. Catches adjacent to the structures were reduced during construction, but returned to pre-construction levels in the post-construction samples. This indicated some degree of avoidance of the harbor entrance by fishes during construction. Collection of numerous unidentified fish eggs and some larvae in addition to ripe adult specimens of several fish species adjacent to the breakwaters indicated that the structures were utilized as spawning habitat.

CONCLUSIONS: No significant adverse biological effects resulting from breakwater construction or channel dredging at West Harbor, Ohio, were detected. Short-term changes in water quality, especially lowered dissolved oxygen concentrations, were noted but not determined to be attributable to project operations. Temporary avoidance by fishes of the immediate vicinity of construction activities, possibly due to elevated turbidities and suspended solids concentrations during dredging activities, was observed. Substratum provided by the breakwaters was rapidly colonized by periphyton and macrozoobenthos. Development of a diverse biological community on the structures created potential foraging as well as spawning habitat for fishes in the project area. Similar biological effects could be expected to result from rubble-mound construction in other coastal areas of the Great Lakes.

ADDITIONAL INFORMATION: Contact Dr. Douglas Clarke of the Coastal Ecology Group, Environmental Laboratory, at (601) 634-3770

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